

REMARKS

The Applicants sincerely appreciate the Examiner's thorough examination of the present application as evidenced by the Office Actions of June 6, 2005, July 27, 2005, and January 12, 2006. In particular, the Applicants appreciate the Examiner's indication that all rejections from the Office Action of July 27, 2005, have been withdrawn. In response, the Applicants will also show in the following remarks that all claims are patentable over U.S. Patent No. 6,380,555 to Hembree et al. (hereinafter "Hembree"). Accordingly, the Applicants respectfully submit that all claims are in condition for allowance, and a Notice of Allowance is requested in due course.

Claim 1 Is Patentable Over Hembree

Claim 1 has been rejected under 35 U.S.C. Sec. 102(e) as being anticipated by Hembree. Claim 1, however, is patentable over Hembree for at least the reasons discussed below.

Claim 1 recites a method of bumping a substrate including a metal layer thereon wherein the metal layer has an exposed portion, the method including:

forming a barrier layer comprising a barrier layer material on the substrate and on the exposed portion of the metal layer;

forming a conductive bump comprising a conductive bump material on the barrier layer wherein the barrier layer is between the conductive bump and the substrate and wherein the conductive bump is laterally offset and laterally separated from the exposed portion of the metal layer in a direction parallel to a surface of the substrate so that the exposed portion of metal layer is free of the conductive bump material; and

after forming the conductive bump, removing the barrier layer from the exposed portion of the metal layer while maintaining a portion of the barrier layer between the conductive bump and the substrate so that the portion of the barrier layer maintained between the conductive bump and the substrate is laterally offset and laterally separated from the exposed portion of the metal layer in the direction parallel to the surface of the substrate and so that the exposed portion of the metal layer is free of the barrier layer material. (Underline added.)

In rejecting Claim 1, the Office Action cites Hembree as disclosing:

forming a barrier layer (78) comprising a barrier layer material on the substrate (54) and on the exposed portion of the metal layer (66);

forming a conductive bump (58) comprising a conductive bump material on the barrier layer (78) wherein the barrier layer (78) is between the conductive bump (58) and the substrate (54) and wherein the conductive bump (58) is laterally offset and laterally separated from the exposed portion of the metal layer (66) (see Figure 2B);

after forming the conductive bump (58), removing the barrier layer (78) from the exposed portion of the metal layer (66) while maintaining a portion of the barrier layer (78) between the conductive bump (58) and the substrate (54) so that the portion of the barrier layer maintained between the conductive bump and the substrate is laterally offset and laterally separated from the exposed metal layer in the direction parallel to the surface of the substrate and so that the exposed portion of the metal layer is free of the barrier layer material (see Figure 2B)....

Final Office Action, pages 2-3.

The Applicants respectfully submit, however, that the conductor 66, the passivation layer 78, and/or the bumped contact 58 shown in Figure 2B of Hembree fail to teach or suggest the metal layer, the barrier layer, and/or the conductive bump of Claim 1. More particularly, Hembree fails to teach or suggest that the passivation layer 78 is between the bumped contact 58 and the substrate 54. As discussed in Hembree:

The bumped contacts 58 are located in openings 82 formed through the outer passivation layer 78 to selected portions of the conductors 66.

Hembree, col. 6, lines 28-31. Accordingly, Hembree fails to teach or suggest forming a conductive bump on a barrier layer wherein the barrier layer is between the conductive bump and the substrate as recited in Claim 1.

Hembree further fails to teach or suggest that the bumped contact 58 is laterally offset and laterally separated from an exposed portion of the conductor 66, and/or that the passivation layer 78 is removed from an exposed portion of the conductor 66 after forming the bumped contact. As best understood by the Applicants, the Final Office Action is interpreting the test contact 60 of Figure 2B of Hembree as an exposed portion of the conductor 66 that is laterally offset and laterally spaced apart from the bumped contact 58. Accepting this interpretation from the Final Office Action for the sake of argument, Hembree fails to teach or suggest removing the passivation layer 78 from the test contact 60 after forming the bumped contact 58. As discussed in Hembree:

The openings 80 can be formed substantially as previously described for the openings 82.

Hembree, col. 7, lines 26-27. Accordingly, Hembree appears to discuss forming the opening 80 (thereby exposing the test contact 60 on conductor 66) concurrently with forming the opening 82

(for the bumped contacts 58), so that portions of the passivation layer 78 are removed from the test contact 60 before (not after) forming the bumped contact 58.

In the alternative that Hembree is somehow interpreted as teaching that portions of the passivation layer 78 are removed from the test contact 60 after forming the bumped contact 58, then Hembree fails to teach or suggest forming the bumped contact 58 so that the bumped contact 58 is laterally offset and laterally separated from an exposed portion of the conductor 66 when the bumped contact is formed (before removing the portions of the passivation layer 78 from the test contact 60 of the conductor 66). In other words, if the opening 80 in the passivation layer 78 (interpreted as a barrier layer) is formed after forming the bumped contact 58, all portions of the conductor 66 are equally exposed/unexposed when the bumped contact 58 is formed so that the bumped contact 58 is not laterally offset and laterally separated from an exposed portion of the conductor 66 when the bumped contact 58 is formed.

For at least the reasons discussed above, the Applicants respectfully submit that Claim 1 is patentable over Hembree. Moreover, Claims 36, 48, and 53 are patentable over Hembree for reasons similar to those discussed above with respect to Claim 1. In addition, Dependent Claims 2-23, 37-47, 50-52, and 54-64 are patentable at least as per the patentability of Claims 1, 36, 48, and 53 from which they depend.

Claims 36 And 48 Are Patentable Over Hembree

Claims 36 and 48 have been rejected under 35 U.S.C. Sec. 102(e) as being anticipated by Hembree. Claims 36 and 48, however, are patentable over Hembree for at least the reasons discussed below.

Claim 36, for example, recites a method of bumping an electronic device comprising a substrate including a metal layer thereon wherein the metal layer has an exposed portion, the method comprising:

forming a barrier layer comprising a barrier layer material on the substrate wherein the barrier layer is laterally offset and laterally separated from the exposed portion of the metal layer in a direction parallel to a surface of the substrate so that the exposed portion of the metal layer is free of the barrier layer material; and

forming a conductive bump comprising a conductive bump material on the barrier layer wherein the barrier layer is between the conductive bump and the substrate,

wherein the conductive bump is laterally offset and laterally separated from the exposed portion of the metal layer in a direction parallel to the surface of the substrate so that the exposed portion of the metal layer is free of the conductive bump material, and wherein the barrier layer, the conductive bump, and the metal layer all comprise different conductive materials. (Underline added.)

As discussed above with respect to Claim 1, Hembree fails to teach or suggest a barrier layer between a conductive bump and a substrate. More particularly, Hembree fails to teach or suggest that the passivation layer 78 is between the bumped contact 58 and the substrate 54. As discussed in Hembree:

The bumped contacts 58 are located in openings 82 formed through the outer passivation layer 78 to selected portions of the conductors 66.

Hembree, col. 6, lines 28-31. Accordingly, Hembree fails to teach or suggest forming a conductive bump on a barrier layer wherein the barrier layer is between the conductive bump and the substrate as recited in Claim 36.

Hembree also fails to teach or suggest a barrier layer that is laterally separated from an exposed portion of a metal layer as further recited in Claim 36. To the extent that the test contact 60 is interpreted as an exposed portion of a metal layer and the passivation layer 78 is interpreted as a barrier layer, Hembree fails to teach or suggest that the passivation layer 78 is laterally separated from the test contact. Because the opening 80 in the passivation layer 78 defines the test contact 60, the passivation layer 78 extends to the test contact 60 and there is no separation therebetween. Accordingly, Hembree fails to teach or suggest a barrier layer that is laterally separated from an exposed portion of a metal layer.

For at least the reasons discussed above, the Applicants respectfully submit that Claim 36 is patentable over Hembree. Moreover, Claim 48 is patentable over Hembree for reasons similar to those discussed above with respect to Claim 36. In addition, Dependent Claims 37-47 and 51-52 are patentable at least as per the patentability of Claim 36 from which they depend.

Claim 53 Is Patentable Over Hembree

Claim 53 has been rejected under 35 U.S.C. Sec. 102(e) as being anticipated by Hembree. Claim 53, however, is patentable over Hembree for at least the reasons discussed below.

Claim 53 recites a method of bumping an electronic device comprising a substrate including a metal layer wherein the metal layer has an exposed portion, the method comprising:

forming a barrier layer comprising a barrier layer material on the substrate wherein the exposed portion of the metal layer and portions of the substrate surrounding the exposed portion of the metal layer are free of the barrier layer material; and forming a conductive bump comprising a conductive bump material on the barrier layer wherein the barrier layer is between the conductive bump and the substrate, wherein the exposed portion of the metal layer and portions of the substrate surrounding the exposed portion of the metal layer are free of the conductive bump material, and wherein the barrier layer, the conductive bump, and the metal layer all comprise different conductive materials. (Underline added.)

As discussed above with respect to Claims 1 and 36, Hembree fails to teach or suggest a barrier layer between a conductive bump and a substrate. More particularly, Hembree fails to teach or suggest that the passivation layer 78 is between the bumped contact 58 and the substrate 54. As discussed in Hembree:

The bumped contacts 58 are located in openings 82 formed through the outer passivation layer 78 to selected portions of the conductors 66.

Hembree, col. 6, lines 28-31. Accordingly, Hembree fails to teach or suggest forming a conductive bump on a barrier layer wherein the barrier layer is between the conductive bump and the substrate as recited in Claim 36.

Hembree also fails to teach or suggest that the test contact 60 (if interpreted as an exposed portion of a metal layer) and portions of a substrate surrounding the test contact 60 are free of the passivation layer 78 (if interpreted as a barrier layer). As discussed above, the test contact 60 is defined by the opening 80 through the passivation layer 78, so that no portion of a substrate surrounding the test contact 60 is free of the passivation layer 78. Accordingly, Hembree fails to teach or suggest an exposed portion of a metal layer and portions of a substrate surrounding the exposed portion of the metal layer being free of a barrier layer material.

For at least the reasons discussed above, the Applicants respectfully submit that Claim 53 is patentable over Hembree. In addition, Dependent Claims 54-64 are patentable at least as per the patentability of Claim 53 from which they depend.

Dependent Claims 4, 38, And 55 Are Separately Patentable Over Hembree

Dependent Claims 4, 38, and 55 have been rejected under 35 U.S.C. Sec. 103(a) as being unpatentable over Hembree. Claims 4, 38, and 55, however, are patentable over Hembree for at least the reasons discussed above with respect to independent Claims 1, 36, and 53 from which they depend. Claims 4, 38, and 55 are also separately patentable for at least the additional reasons discussed below.

Claim 4, for example, depends from Claim 1 and thus includes all recitations of Claim 1 as discussed above. In addition, Claim 4 recites that the barrier layer comprises a layer of TiW (titanium-tungsten). The Final Office Action cites the passivation layer 78 of Hembree as disclosing the barrier layer of Claims 1 and 4. In addition, the Final Office Action states that:

Hembree discloses the claimed invention except for specific materials. It would have been obvious to one having ordinary skill in the art at the time the invention was made to select specific material to be apply to fabricate a semiconductor device, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice.

Final Office Action, page 7.

As discussed above, the Final Office Action cites the passivation layer 78 of Hembree as teaching a barrier layer. The Applicants respectfully submit, however, that the passivation layer 78 of Hembree teaches away from a barrier layer comprising a layer of TiW. In particular, Hembree states that:

The outer passivation layer 78 of the redistribution circuit 56 comprises a dielectric material blanket deposited the face 84 of the die 54, and adapted to insulate and protect the conductors 66. (Underline added.)

Hembree, col. 6, lines 59-62. The dielectric passivation layer 78 adapted to insulate thus teaches away from a layer of TiW which is a conductive alloy/mixture of the metals titanium and tungsten.

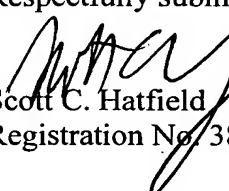
The Applicants thus submit that Claim 4 is separately patentable over Hembree. The Applicants further submit that Claims 38 and 55 are separately patentable for reasons similar those discussed above with regard to Claim 4.

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CONCLUSION

Accordingly, the Applicants submit that all pending claims in the present application are in condition for allowance, and a Notice of Allowance is respectfully requested in due course. The Examiner is encouraged to contact the undersigned attorney by telephone should any additional issues need to be addressed.

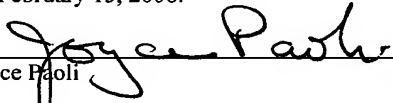
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